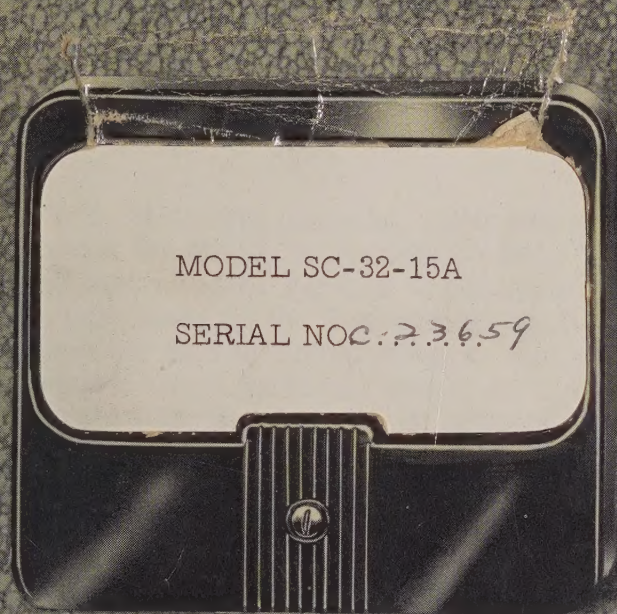
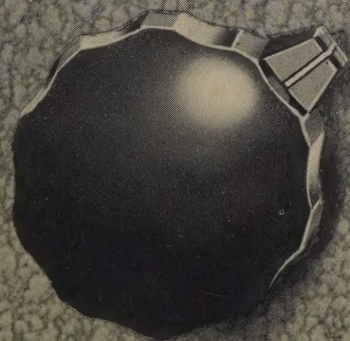


Kepeco

INSTRUCTION MANUAL



✱ **VOLTAGE
REGULATED
POWER
SUPPLIES**





MODEL SC-32-15A

SERIAL NOC: 23659

KEPCO, INC.
131 - 38 Sanford Avenue
Flushing 55, New York

Kepco, Inc.
Flushing, New York

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TABLE OF CONTENTS

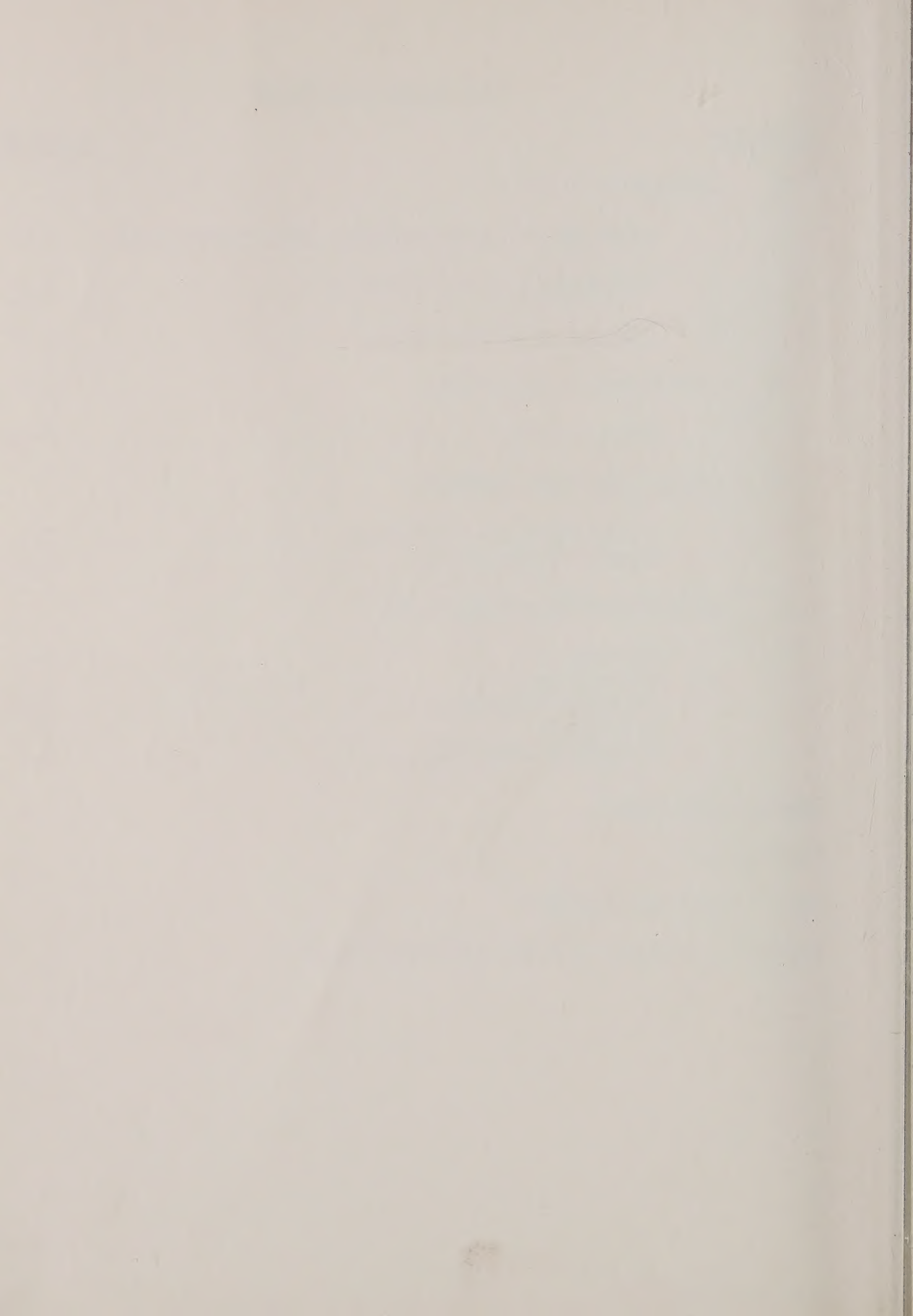
<u>SECTION</u>	<u>PAGE NO.</u>
A. SPECIFICATIONS	
I. ELECTRICAL AND PHYSICAL SPECIFICATIONS	A-1
II. TERMINALS AND CONTROLS	A-2
III. PROTECTIVE FEATURES	A-3
B. THEORY OF OPERATION	B-1
Block Diagram.....	B-1A
C. OPERATING PROCEDURES	
Initial "Turn-On" Procedure.....	C-1
Remote Error Sensing.....	C-2
D. MAINTENANCE AND REPAIRS	
General.....	D-1
Precautions.....	D-2
Checking Transistors.....	D-3
Regulation.....	D-5
Trouble Shooting Chart.....	D-8

REFERENCE INDEX

Parts Lists

Parts Location Photographs

Schematic Diagrams of Power and Control Units



SECTION A

SPECIFICATIONS AND CONTROLS

I. ELECTRICAL AND PHYSICAL SPECIFICATIONS:

- DC OUTPUT VOLTAGE:
0-32 volts DC, continuously variable.
- DC OUTPUT CURRENT:
0-15 amperes, continuous duty.
- AC INPUT:
105-125 volts, 50-65 CPS.
- REGULATION:
 - Line: Less than 0.01% for AC line fluctuations from 105-125 volts at any output voltage in the specified range.
 - Load: Less than 0.01% or 0.002 volts, whichever is greater, for 0 to 15 ampere step load change, at any output voltage in the specified range.
- RIPPLE:
Less than 0.001 volt rms.
- STABILITY:
Output variation is less than 0.01% or 0.002 volt, whichever is greater, over a period of 8 hours after unit has reached equilibrium. Approximately 3/4 of an hour is required for this unit to reach equilibrium from a "cold start". Drift during warm-up is less than 1%.
- OUTPUT IMPEDANCE:
Less than 0.001 ohm from DC to 1 KC.
Less than 0.01 ohm from 1 KC to 100 KC.
- RECOVERY TIME:
50 microseconds.
- TEMPERATURE COEFFICIENT:
Output voltage changes less than 0.01% per °C.
- AMBIENT OPERATING TEMPERATURE:
-20°C to 50°C maximum. Protective circuit turns off unit whenever over-temperature condition occurs. Interrupting input power resets unit.

.....STORAGE TEMPERATURE:

-40°C to +85°C.

.....*METERS (If specified):

Voltmeter: 0-50 volts, 2-1/2".

Ammeter: 0-15 amperes, 2-1/2".

.....DIMENSIONS:

Height 8-3/4", width 19", depth 14-3/8".

.....COLOR:

Kepco standard gray hammertone.

II. TERMINALS AND CONTROLS:

.....(On front panel):

....DC OUTPUT AND GROUND binding posts, clearly marked. Output terminals isolated from chassis; either positive or negative terminals may be grounded.

....VOLTAGE CONTROL continuously variable, one turn, for setting the desired output voltage.

....POWER ON-OFF toggle switch.

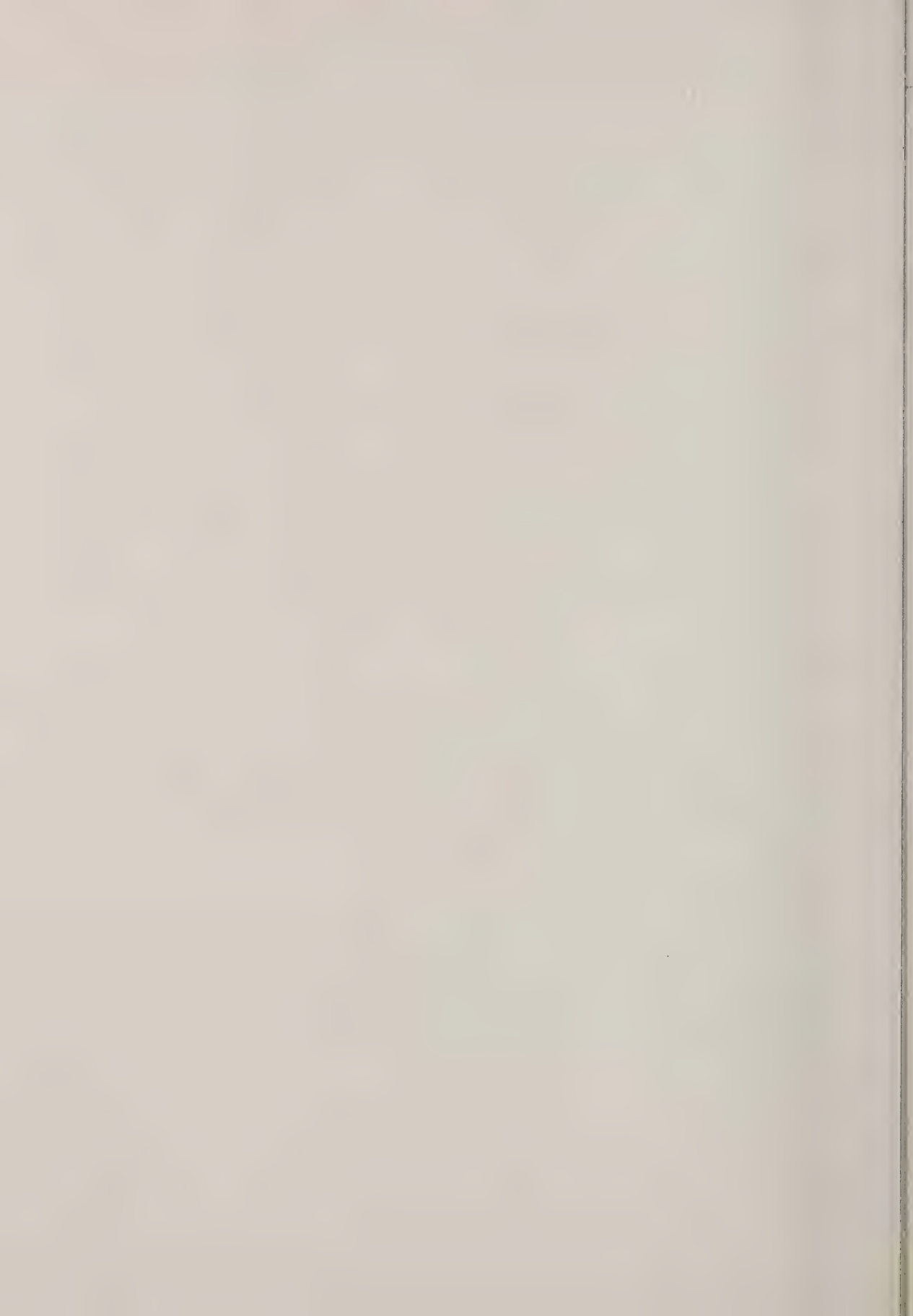
.....(On terminal board at rear of unit):

....DC OUTPUT AND GROUND terminals, clearly marked; either positive or negative output may be grounded.

....REMOTE ERROR SIGNAL terminals provide means of maintaining specified regulation directly at the load by compensating for voltage drops across load supply leads. (See Diagram and Procedure on Page C-1).

.....(On Control Unit, Tram 8, at rear of unit):

....MAXIMUM CURRENT ADJUST (MC): This adjustment is factory-set to automatically limit the output current to 120% of its maximum rating. If a current limiting effect is introduced by the voltage drop across the load supply leads, when using remote error sensing, the Maximum Current Adjust may be set clockwise to compensate for this effect. Care should be taken to see that this control is returned to its normal setting for standard operation.



III. PROTECTIVE FEATURES:

.....SHORT CIRCUIT PROTECTION:

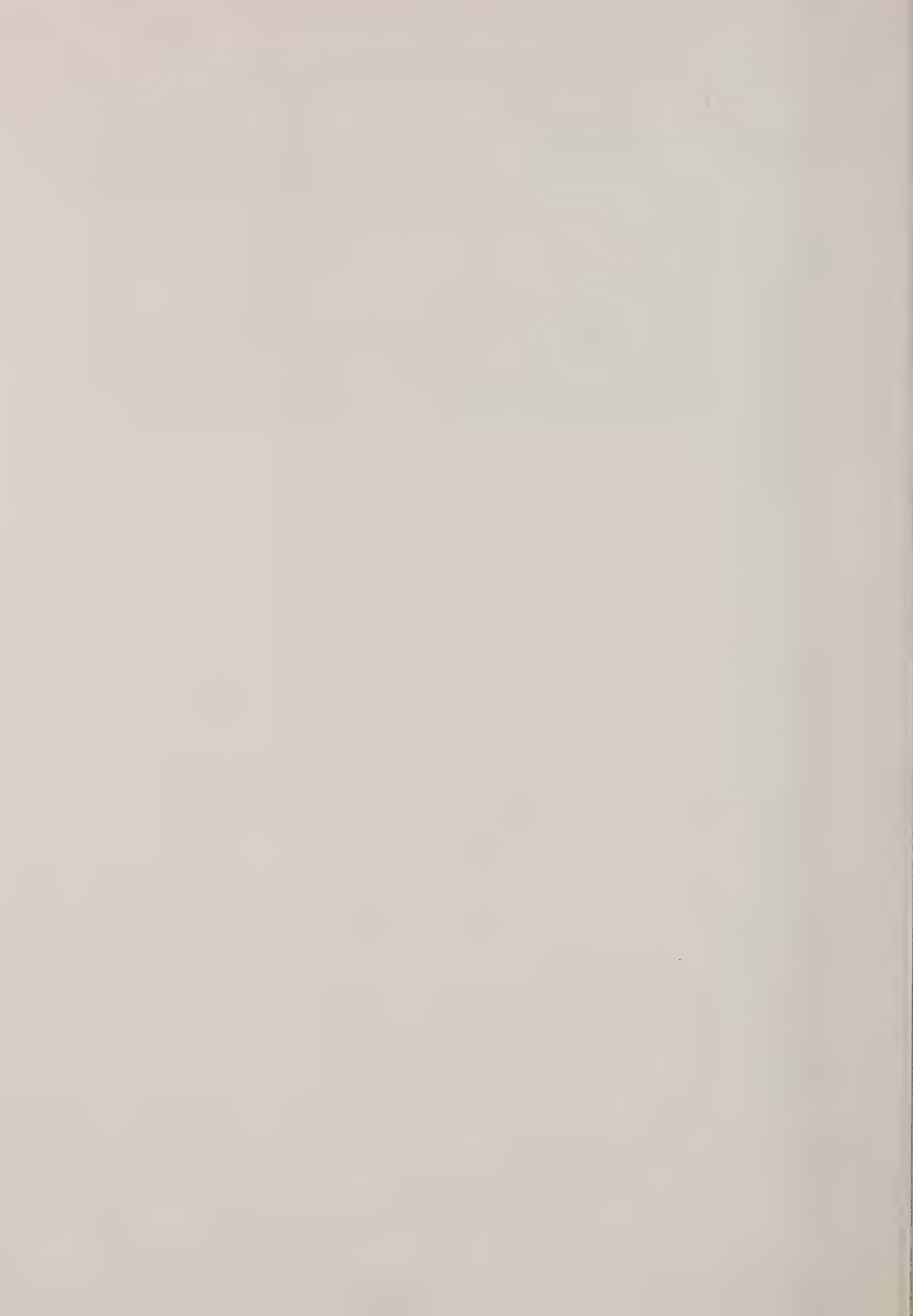
When the load exceeds the maximum permissible output current by 20% the limiter amplifier automatically increases the impedance of the series pass transistors, so that their dissipation rating is never exceeded.

.....FUSE PROTECTION:

INPUT FUSE on front panel.

REFERENCE FUSE on rear apron of chassis.

POT FUSE on rear apron of chassis. This fuse has been designed into the circuit to protect the 10 turn voltage control in the event of any internal failure or accidental removing of jumper bars on the rear **terminations** when the unit is operating.



SECTION B.

THEORY OF OPERATION

This power supply is of a servo or closed loop design in which the pass elements are in series with the load. (See block diagram B-1).

The voltage drops in the closed loop system are automatically adjusted according to the comparison of a sample output voltage with the reference voltage in the CONTROL UNIT. The differential product of this comparison is amplified and fed back as the ERROR INPUT to control the voltage drop across the pass transistors. The ERROR INPUT to the PASS CIRCUITRY is a negative or degenerative feedback signal. Consequently, the voltage drop across the pass transistors is such as to oppose output voltage change.

CAPITALIZED TERMS ADOPTED FOR FOLLOWING OUTLINE AND DISCUSSION REFER TO DESIGNATIONS ON THE CIRCUIT SCHEMATICS IN THE REFERENCE INDEX.

....I.- POWER UNIT (Circuit Schematic Tile)

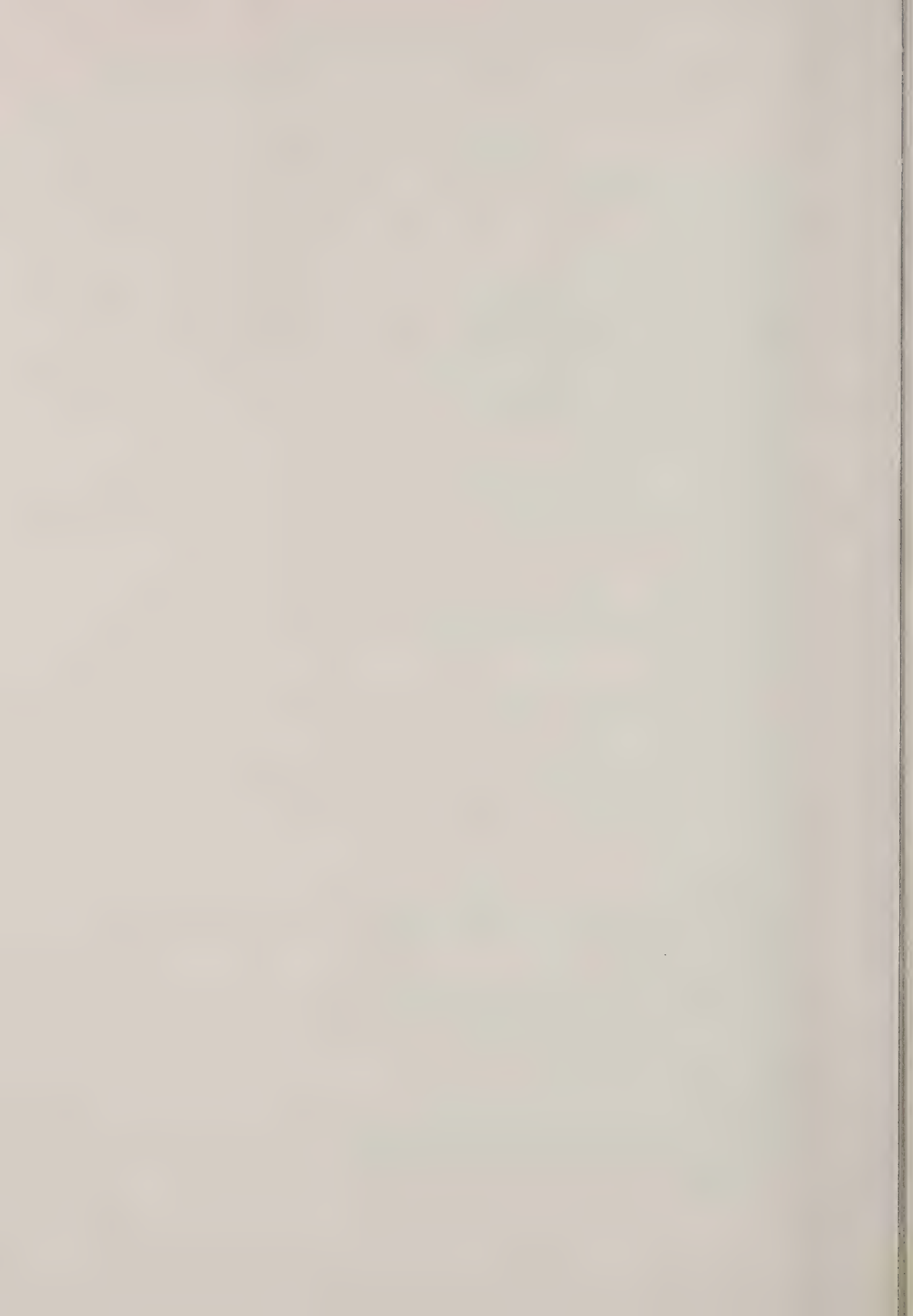
- A. INPUT CONTROL CIRCUITRY - Controls power input from the line to the DC SOURCES.
- B. DC SOURCES - Provide main and auxiliary rectified power for all DC circuitry.
- C. PASS CIRCUITRY - In the MAIN DC path to the output. All current drawn by the load goes through the pass elements, hence the name.

....II. CONTROL UNIT (Circuit Schematic Tile)

- A. REFERENCE VOLTAGE CIRCUITRY - Maintains a stable voltage standard for the comparison circuitry.
- B. THE COMPARISON AMPLIFIER - Functions as the "error sensing" and cascade amplification circuit.

....III. COMPARISON BRIDGE -

Consists of elements in both the POWER UNIT and CONTROL UNIT in a circuit configuration which effects a comparison between an output voltage sample and a stable reference voltage.



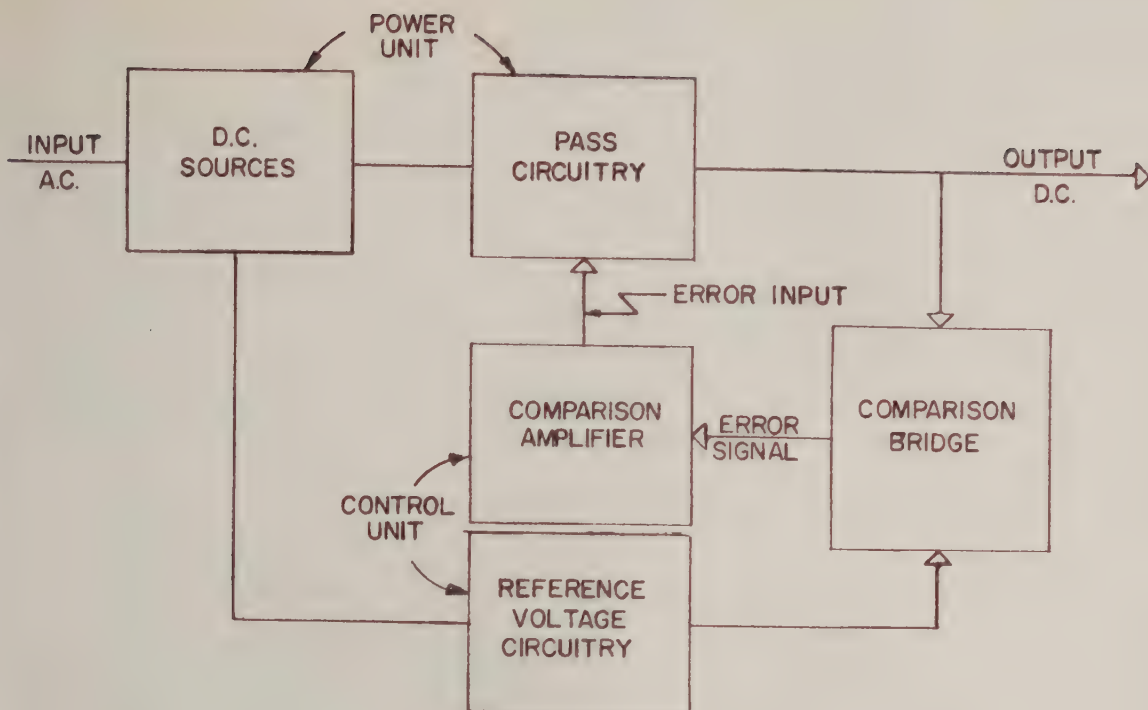


DIAGRAM B-1

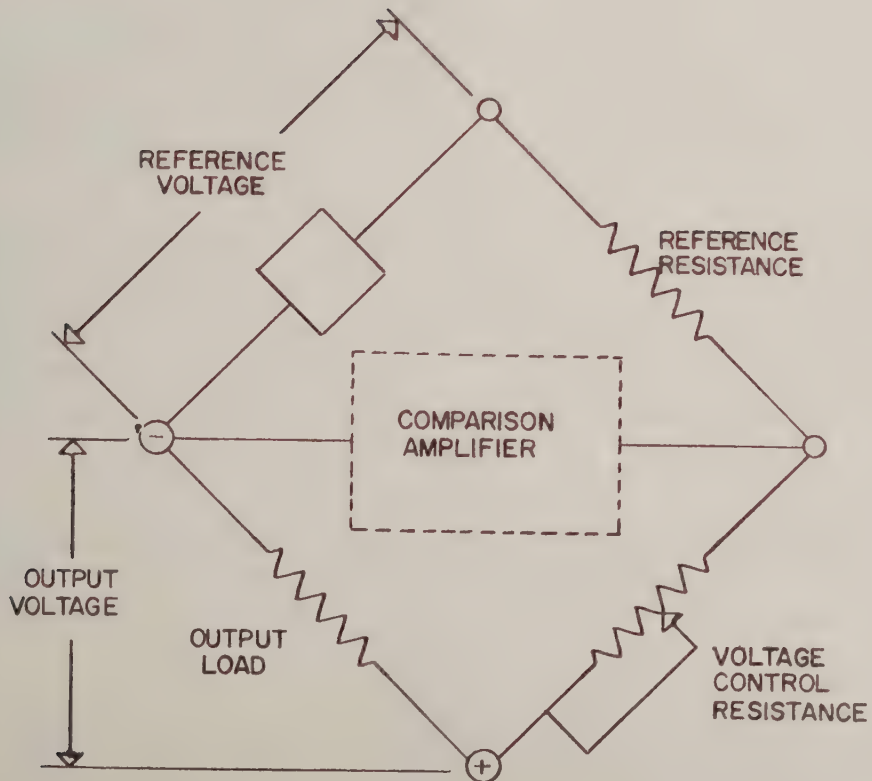


DIAGRAM B-2

NOTE:

The following discussion describes the elements of the foregoing outline in greater detail. As before, capitalized terms refer to designations on the schematic diagrams. Some of this discussion is of a general nature and may not apply in every detail to this specific model. Variations in the basic outline occur primarily in connection with the PASS CIRCUITRY INPUT CONTROL CIRCUITRY or the REFERENCE VOLTAGE CIRCUITRY and reflect design considerations relevant to the particular output requirements of the model. It should not be assumed that a set of circuit schematics is incomplete because it does not include all of the reference nomenclature used in this discussion.

...I. POWER UNIT

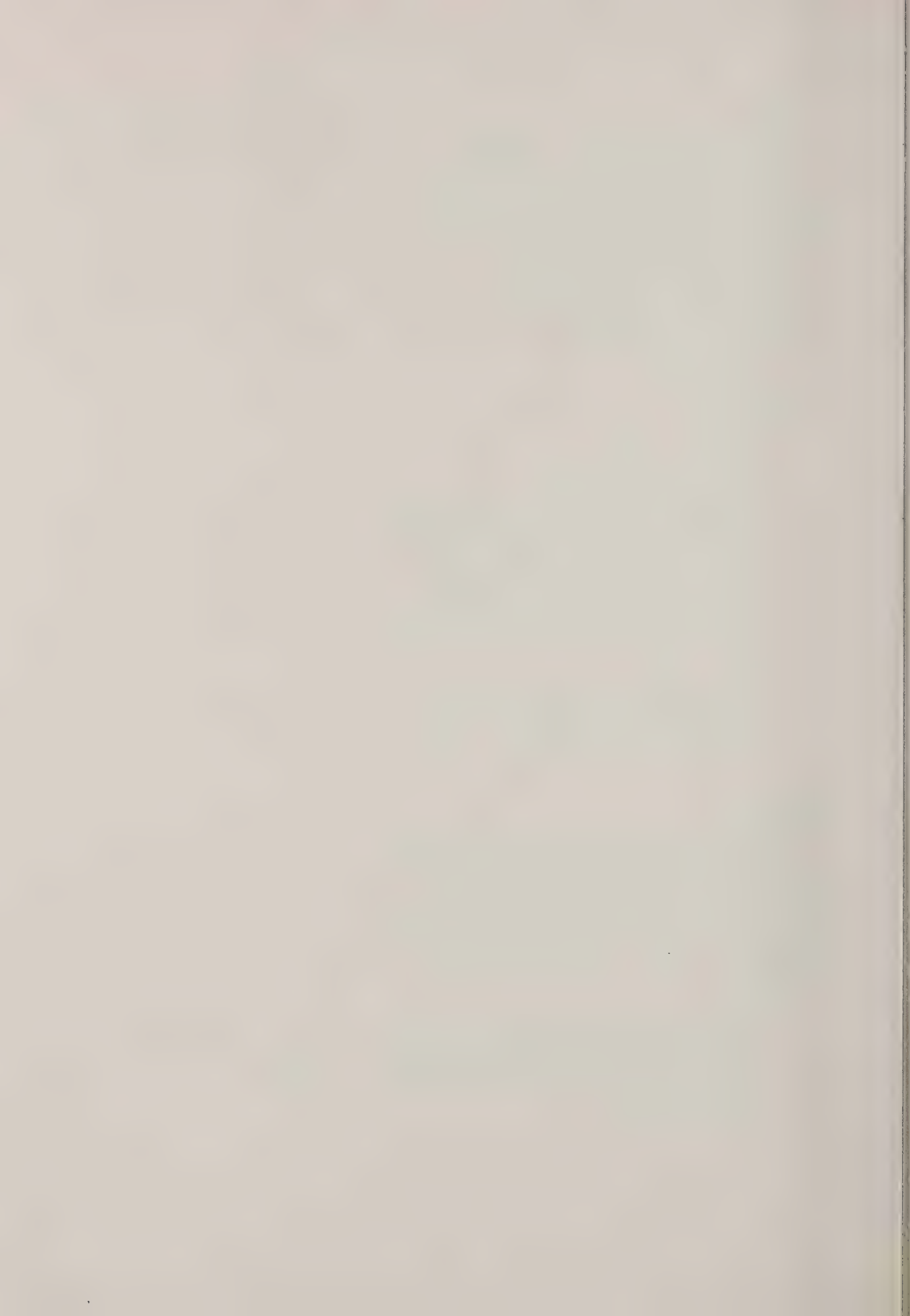
A. INPUT CONTROL CIRCUIT:

- (1) With the input switch closed, a forward bias on one semiconductor diode in the ENERGIZING CIRCUIT will draw a charging current for the capacitor which energizes the INPUT RELAY coil closing the input to the DC SOURCES transformers. As soon as the INPUT RELAY is closed, the DC in the input control circuit circulates through the thermal relay and input relay coil, bypassing the charged capacitor and holding the relay closed.
- (2) If the pass element containing the thermostat control becomes overheated, the thermal switch opens the DC path to the INPUT RELAY de-energizing the relay coil and cutting off the input to the DC SOURCES.

NOTE:

The AC line power must be interrupted in order to reset the input relay after the thermal switch has opened the input to the DC SOURCES. Once the capacitor in the ENERGIZING CIRCUIT is charged, it cannot hold the relay when the thermal switch opens. This action tends to prevent damage to the pass elements from overheating in case the transistor associated with the thermostat dissipates heat faster than the other pass elements.

- (3) When the input relay is opened by the action of the thermal switch or by pulling the line cord, the DISCHARGE RESISTOR effectively shorts the MAIN FILTER CAPACITOR preventing over-voltage surges.



B. DC SOURCES:

- (1) RETURN SUPPLY (full wave rectified and filtered) - provides a return path for leakage current (I_{CO}) from the pass transistors.

It is also a bleed path which provides a minimum operating current for the emitters of the pass transistors, enabling them to continue to remain operative or "sensitive" to the ERROR INPUT when the load current becomes zero or vanishingly small.

- (2) MAIN SUPPLY (full wave rectified and filtered) - provides MAIN DC for the output, subject to the regulatory action of the PASS CIRCUITRY. The MAIN DC path includes the pass elements and the load in series.

- (3) I_{CO} SUPPLY (full wave rectified) - Provides a supply of current to prevent spurious biasing of the pass transistors by collector leakage current (I_{CO}). I_{CO} generated as a function of temperature and flowing oppositely to the emitter base current tends to alter the ERROR INPUT unless this compensating supply provides bias stabilization.

- (4) COLLECTOR SUPPLIES (negative half-cycle rectified) - provide proper collector bias for the PRE-DRIVERS.

C. PASS CIRCUITRY:

The power transistors which function as pass elements may be regarded as electronic variable resistors (or variable conductors) controlled or "varied" by an amplified ERROR INPUT. The amount of current "passed" by these transistors is a function of the magnitude of the forward conducting emitter-base bias. Since the ERROR INPUT is applied to the base terminal, a negative input will aid the forward conducting bias of a PNP transistor while a positive input will reduce the forward conducting bias. In response to the polarity and magnitude of the ERROR INPUT, the pass transistors control the current and voltage distribution in the MAIN DC loop and effect a constant output voltage.

Two main classifications of pass transistors may be indicated on the schematic according to the way in which they are driven:

- (1) DRIVEN PASS - "driven" by the ERROR INPUT from the CONTROL UNIT. A DRIVER and a PRE-DRIVER may be connected in cascade with the DRIVEN PASS. These amplification stages increase the response and sensitivity of the system to output voltage changes. The DRIVEN PASS may be a single series pass transistor

or a series pass group of transistors connected in parallel for increased current capacity.

(2) SLAVE PASS - found in transistorized units requiring more than one series pass group in the MAIN DC path. These pass transistors "slavishly" follow the response of the DRIVEN PASS to the ERROR INPUT. The SLAVE PASSES are driven through a SLAVE VOLTAGE DIVIDER which effects an approximately equal voltage division among the series pass groups in models where the voltage range requires more than one group of series pass elements. The SLAVE PASSES may or may not have preliminary amplification stages in cascade.

When series pass groups contain transistors connected in parallel, an EQUALIZING RESISTOR is associated with each transistor. These EQUALIZING RESISTORS, tied to each emitter, provide a means of compensation for intrinsic differences among transistors within a pass group.

The expression "drop voltage" is sometimes used to describe the amount of voltage drop required of the pass elements to bring the COMPARISON BRIDGE into balance. This is the difference between the input and the desired output. True balance or stability is inherently impossible in a servo system, but the unbalance may be reduced to as small a magnitude as desired in a dynamically corrective system.

...II. CONTROL UNIT

A. REFERENCE VOLTAGE CIRCUITRY:

The function of the REFERENCE VOLTAGE CIRCUITRY is to maintain a precise, stable voltage for the COMPARISON BRIDGE. This is normally achieved according to the model CONTROL UNIT with either of two basic design approaches:

(1) A CASCADE ZENER REFERENCE, consisting of Zener diodes of successively decreasing values in cascaded stages each of which produce an increasingly regulated reference voltage. In practice, usually only two stages are used so that in effect the first Zener diode is a regulator for a voltage reference diode.

(2) Balanced amplifier regulation - Any disparity between the bases of the transistors in the set of 1st BALANCED AMPLIFIERS is coupled to the set of 2nd BALANCED AMPLIFIERS. The 2nd BALANCED AMPLIFIERS couple this amplified "error signal" to a REFERENCE DRIVER and a REFERENCE PASS which regulate the current through a REFERENCE DIODE in a manner analogous to the action of the PASS CIRCUITRY in the POWER UNIT.

B. COMPARISON AMPLIFIER CIRCUITRY:

(1) The COMPARISON AMPLIFIER consists of a series of cascaded transistor amplifiers which boost the "error input" to a sufficient level to drive the PASS CIRCUITRY in the POWER UNIT.

(2) The COMPARISON AMPLIFIER is connected across the COMPARISON BRIDGE from the junction of the VOLTAGE CONTROL and the REFERENCE RESISTANCE to the junction of the Zener reference diode and the negative output terminal. (See Diagram B-2). This arrangement is similar to that of the null galvanometer across a Wheatstone bridge. The unbalance in the COMPARISON BRIDGE is detected and amplified by the COMPARISON AMPLIFIER CIRCUITRY beginning a chain of circuit responses which produce an ERROR INPUT signal of proper phase and magnitude to effect corrective action by the pass circuitry.

.....III. Comparison Bridge:

(1) This bridge circuit implements the comparison between the OUTPUT VOLTAGE and the REFERENCE VOLTAGE. The signal produced by the comparison drives the COMPARISON AMPLIFIER CIRCUITRY.

(2) The Comparison Bridge is represented schematically in Diagram B-2.

(3) Balance occurs in the Comparison Bridge when the following ratios are equal:

$$\frac{\text{Output Voltage}}{\text{Voltage Control Resistance}} = \frac{\text{Reference Voltage}}{\text{Reference Resistance}}$$

(4) When the Comparison Bridge is unbalanced by a decreasing output voltage drop across the load, it gives rise to a negative bias at the base of the COMPARISON FOLLOWER in the COMPARISON AMPLIFIER CIRCUITRY. This signal, amplified, acting as the ERROR INPUT negatively biases the base of the DRIVEN PASS, aiding its forward conducting bias and increasing the output voltage.

(5) A bridge unbalance caused by an increasing output voltage produces, of course, a chain of oppositely biased circuit responses which reduce the voltage across the load.

THIS POWER SUPPLY:

- is shipped without any internal packing material and may be put into operation right away.
- is designed for rack or bench use. Carrying handles are provided on front panel.
- incorporates carefully selected and tested components which assure long trouble free operating life. However, resistor board construction and plug-in sub-assemblies provide exceptional component accessibility should servicing be required. Any servicing should be handled by personnel experienced in transistor circuitry. Serious and costly damage can result from inexperienced probing.
- should not be returned to the factory without proper authorization and shipping instructions. In any correspondence with the factory concerning repair, the model and serial number of the instrument must be supplied together with a description of the trouble encountered.

INITIAL "TURN-ON" PROCEDURE:

1. Rotate voltage control to approximate mid-range position.
2. With power ON-OFF switch in "OFF" position, plug line cord into 115 VAC 60 cps power receptacle. If the outlet is not polarized, use 3 to 2 prong adaptor supplied with unit.
3. Turn power ON-OFF switch to "ON" position.
4. Set output voltage to desired value by rotating voltage control.

REMOTE ERROR CONNECTIONS

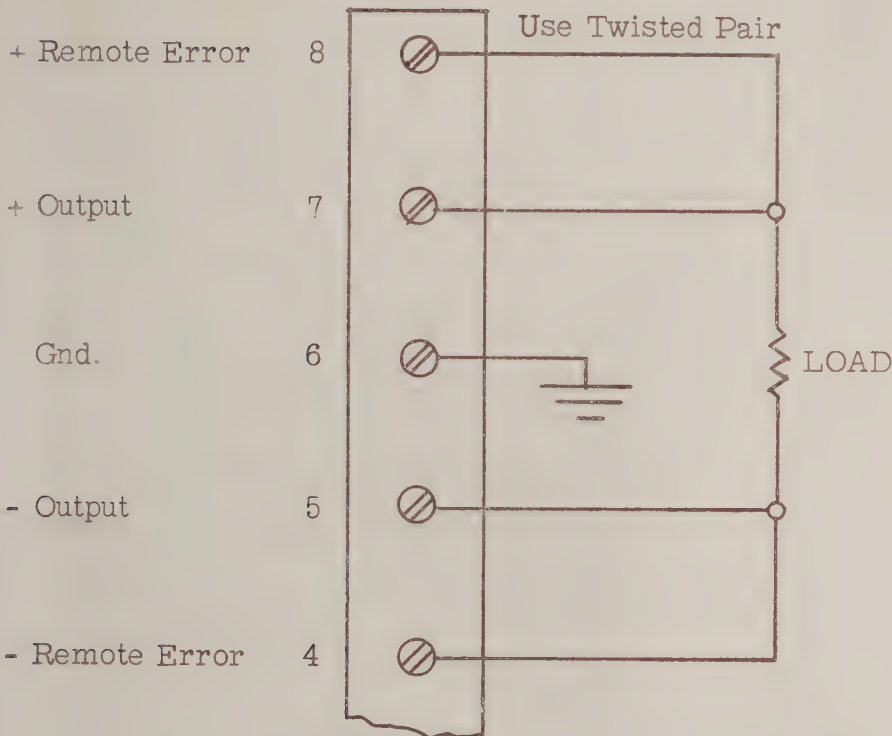


FIGURE.

1. With A.C. input power disconnected, remove jumpers between OUTPUT terminals and REMOTE ERROR SIGNAL terminals (terminals 4 and 5, 7 and 8).
2. Using twisted pair wire, connect sensing leads from positive and negative REMOTE ERROR SIGNAL terminals (terminals 4 and 8) to the load (observe polarities).
3. Using twisted pair wire, connect load supply leads from positive and negative OUTPUT terminals (terminals 5 and 7).

SECTION D

MAINTENANCE AND REPAIRS

.....GENERAL:

(1) In servicing this equipment it should be remembered that the essential regulating circuitry is a closed loop DC servo system. Careless servicing may affect the whole system. The same circuit sensitivity which enables a high degree of regulation to be obtained also increases the susceptibility of the circuit components to interrelated functional disorders when the equipment is abused. No component is an "island entire in itself". Consequently, exercise the greatest care in making repairs.

(2) Before any systematic trouble-shooting is attempted, it is advisable to establish by careful examination whether any malfunction is attributable to "simple" mechanical disorders: broken leads, loose plugs, etc. Obviously, many "simple" disorders may be symptomatic, that is, effects rather than causes of equipment malfunction.

(3) The components of this power supply have been tested and selected to provide long and trouble free operation. Under normal operating conditions, maintenance will consist merely in oiling the fan every six months. However, if component failure occurs the unit should be serviced by personnel who are thoroughly familiar with transistor circuitry. SERIOUS, COSTLY DAMAGE CAN RESULT FROM CARELESS PROBING.

(4) PARTS LOCATION: New, revised, Instruction Manuals include Parts Location Photos. These photos together with schematic diagrams should facilitate trouble-shooting and replacement.

(5) CONTROL UNITS: Control Units or "TRAMS" are of a semi-modular plug-in design. (However, it is necessary, according to the particular model, to remove bracket screws or stand-off screws before the CONTROL UNITS can be unplugged.)

.....PRECAUTIONS:

(1) CHECK ALL TRANSISTORS BEFORE REPLACING ANY. IF ASSOCIATED TRANSISTORS ARE DEFECTIVE, THE REPLACEMENT MAY BE IMMEDIATELY RUINED.

(2) IF MAJOR REPAIRS ARE NECESSARY, THE FACTORY IS PREPARED TO HANDLE THEM. UNDER NO CIRCUMSTANCES SHOULD THE UNIT BE RETURNED TO THE FACTORY WITHOUT PROPER AUTHORIZATION AND SHIPPING INSTRUCTIONS. IN ANY CORRESPONDENCE WITH THE FACTORY CONCERNING REPAIRS, THE MODEL AND SERIAL NUMBER OF THE UNIT MUST BE GIVEN TOGETHER WITH A DESCRIPTION OF THE TROUBLE ENCOUNTERED.

(3) Check all fuses before applying power after any repairs or replacements have been made.

(4) If it is found that the output voltage cannot be varied over its entire range by means of the voltage control adjustment, be careful not to short the supply as severe damage to the unit may result. In this regard, if it is detected that the output voltage does not decrease as the

voltage control is turned counter -clockwise, DO NOT CONTINUE TO TURN THE CONTROL.

(5) If it is necessary to solder transistor terminals, it is recommended that the leads be held with pliers between the transistor and the point to be soldered in order to shunt heat and reduce the possibility of damage to semi-conductor junctions. This applies as well to semi-conductor diodes.

.....CHECKING TRANSISTORS:

(1) Since a transistor is essentially a combination of semi-conductor diodes, a short in both directions between any two of its terminals is sufficient indication that the transistor is defective. Characteristically, the ratio of the forward to the reverse resistance across a transistor junction should be at least 100. In the majority of cases, the bi-directional short will occur between the collector and emitter terminals. Occasionally, a short will occur between the base and either of the other two terminals, but this condition is usually compounded with an emitter-collector short.

(2) HIGH POWER TRANSISTORS - If possible, a power transistor checker should be employed, but on a Go-No-Go basis an ohmmeter will prove adequate to detect defective components. USING THE RX1 SCALE OF THE OHMMETER, TEST FOR SHORT WITH ONE POLARITY; REVERSING POLARITIES, TEST FOR SHORT IN THE REVERSE DIRECTION. PASS TRANSISTOR groups containing elements in parallel may be checked collectively without removal from the circuit. This is done by connecting an ohmmeter directly across the collector emitter terminals

of the pass elements. If any one of the transistors in parallel is shorted, the group will, of course, be shorted and require individual checking.

NOTE: PASS TRANSISTORS are mounted in most models on the chassis in plug-in heat sinks called "STATS". In early models these STATS could be disconnected simply by pulling the STAT plug from its socket. In the newer models, for increased structural rigidity, the STATS are fastened by self-tapping hex-head screws which must be removed from the underside of the chassis.

(3) LOW POWER TRANSISTORS - Can be adequately tested using standard "packaged" transistor checkers (e.g. Baird-Atomic Beta-h₁₁ Model KT-1, Barber Labs. Junction Transistor Checker Model #29).
IMPORTANT: BE SURE THE PNP-NPN SELECTOR SWITCH IS IN THE CORRECT POSITION.

NOTE: Associated with each PASS TRANSISTOR connected in parallel within a pass group is a low-value resistor, called an "equalizing resistor", which operates to equalize current distribution among the pass elements. It should be ascertained whether or not a defective equalizing resistor is contributing to or has resulted from operational disorders. If one of these resistors "burns open" it effectively removes a pass transistor from the main circuit and increases the dissipation requirements of the remaining elements.

.....REGULATION:

(1) GENERAL - The regulation of this unit has been precisely measured and found to conform to specification. It must be emphasized that when the regulation specification is of a low order of magnitude great care must be exercised in proceeding to verify this measurement. Otherwise, inaccuracies may be introduced by the test. For example: a full load current drawn through an uncompensated internal resistance of 0.0002 ohm in a 32 volt-15 ampere, 0.01% regulated power supply operating at maximum voltage will produce a voltage drop equal to the % regulation specification. This amount of resistance might easily be introduced by improper setup connections for regulation measurement.

(2) DEFINITIONS -

Line Regulation is specified as the % change in output voltage as the line voltage is varied from minimum to maximum or vice versa, with the load held at a constant value.

Load Regulation is specified as the % change in output voltage as the load is varied from minimum to maximum or vice versa, with the line voltage held at a constant value.

(3) INSTRUMENTATION -

a) A differential voltmeter or Kepco Regulation Analyzer 901B can be used to measure regulation.

The output may also be monitored by a DC coupled oscilloscope provided a buck-out device is employed. The buck-out source should be of a better order of regulation than the

power supply being tested, and for maximum sensitivity the buck-out source should provide a voltage of magnitude comparable to the output setting of the supply being tested.

- b) A Variac or line voltage adjuster (e.g. Kepco Model 920B) and an AC voltmeter (e.g. Weston or equivalent) can be used to control and measure the line voltage.
- c) Variable Load Resistance.

(4) CONNECTIONS - A major source of inaccuracy in measuring regulation is uncompensated voltage drops due to improper connections. Regulation should be measured at the Remote Error Signal or Output Terminals on the terminal board with the load taken from either front or rear output terminals.

IT IS STRONGLY RECOMMENDED THAT CONNECTIONS FOR THE INSTRUMENTATION SET-UP FOR MEASURING REGULATION BE MADE BY LOOPING #14 BUSS AROUND the Remote Error Signal or Output terminal SCREWS ON THE TERMINAL BOARD (with jumpers in place). (See Diagram following this section.)

(5) CAUTION -

- a) To prevent possible deterioration of regulation due to voltage drops across the internal buss connecting front and rear output terminals, avoid measuring regulation at the front terminals when the load is taken from the rear output.
- b) When the load is remotely located with respect to the power supply or load current requirements are high, voltage drops

across output leads must be compensated for by converting to Remote Error Signal operation. (See Section C of this manual)

- c) If the load is split between the front or rear output terminals, the load at the rear will receive the best regulation, the front output voltage being higher by the amount of voltage drop in the internal buss.

.....FACTORY RETURNS:

It is important that units returned to Kepco for repair be tagged with a brief description of the defects observed by the customer.

This will greatly facilitate the recording, handling and scheduling necessary to expedite servicing.

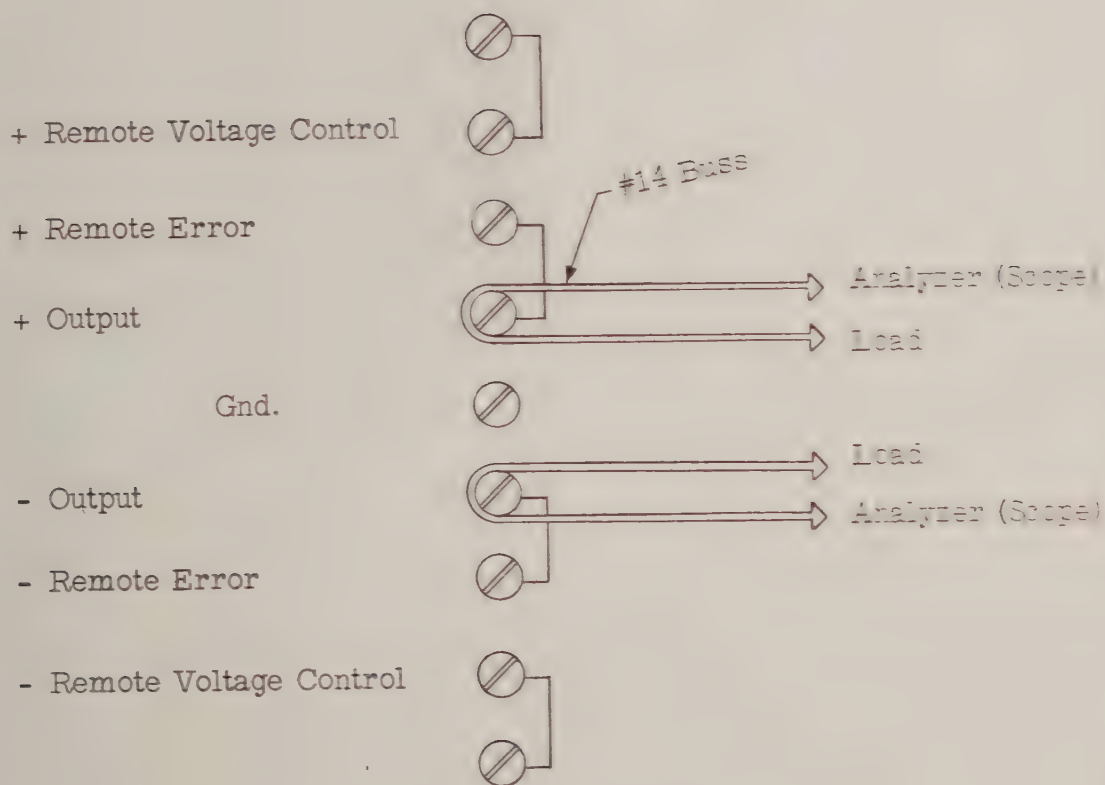
Under no circumstances should the unit be returned to the factory without proper authorization and shipping instructions. In any correspondence with the factory concerning repairs, the model and serial number of the unit must be given.

Cause numbers
indicate order
of probability

TROUBLE-SHOOTING CHART

SYMPTOM	CAUSE
A. NO OUTPUT	1. Overtemperature relay activated by: a. blocked ports b. ambient temperature too high c. defective fan d. defective relay 2. Input fuse blown by short in: - rectifiers, transformer, - main supply filter capacitor 3. Defective Control Unit (TRAM) 4. Defective ammeter
B. NO REGULATION	1. Defective pass elements
HIGH OUTPUT VOLTAGE; VOLTAGE CONTROL DOES NOT DECREASE OUTPUT VOLTAGE (EXCEPT IN VARIAC UNITS).	2. Open Voltage Control Potentiometer 3. Defective Control Unit (TRAM) 4. Defective Driver or Pre-Driver associated with Pass Transistors
C. NO REGULATION	1. Current Limit Adjust set too low
LOW OUTPUT VOLTAGE	2. Defective Control Unit (TRAM) 3. Incorrect conversion to remote error operation 4. Defective Main Filter capacitor

CONNECTIONS FOR REGULATION MEASUREMENT



PARTS LIST OF POWER UNIT - MODEL SC-32-15A

DRAWING S-SC-32-15A-02

B201	-	Fan	
C101	-	1 MF	200 WV
C201 thru C206	-	2400 MF HC 6524	65 WV
C207 thru C209	-	4000 MF HC 5040	50 WV
C210	-	0.1 MF	500 WV
C211 thru C214	-	0.5 MF	200 WV
C301	-	500 MF	12 WV
C302	-	500 MF	12 WV
C303	-	350 MF	50 WV
C304	-	100 MF	150 WV
C305	-	0.4 MF	200 WV
C306	-	0.4 MF	200 WV
C401	-	10 MF	150 WV
C402	-	0.22 MF	200 WV
C403	-	10 MF	150 WV
CR201	-	Silicon Rectifier 4T1015B1S1	
CR301 thru CR306	-	Germanium Rectifier 1N91	
CR307 thru CR310	-	Silicon Rectifier PT-5	
CR401 and CR402	-	Silicon Rectifier PT-5	
F101	-	15 Amp. Fuse	
F201	-	1/4 Amp. Fuse	
F202	-	1-1/2 Amp. Fuse	
M101	-	Meter, 0-15 A DC	
M102	-	Meter, 0-50 V DC	
PL101	-	Neon Pilot Light NE-51	
Q301	-	Transistor 2N382 (Alternate 2N383)	
Q901 thru Q931	-	Transistor 2N441-10	
R101	-	10 K	10 turn Pot.
R201	-	.033 Ohm	15 watt
R202	-	250 Ohm	40 watt WW
R203	-	100 Ohm	40 watt WW
R204	-	500 Ohm	20 watt WW

PARTS LIST - MODEL SC-32-15A

DRAWING S-SC-32-15A-02

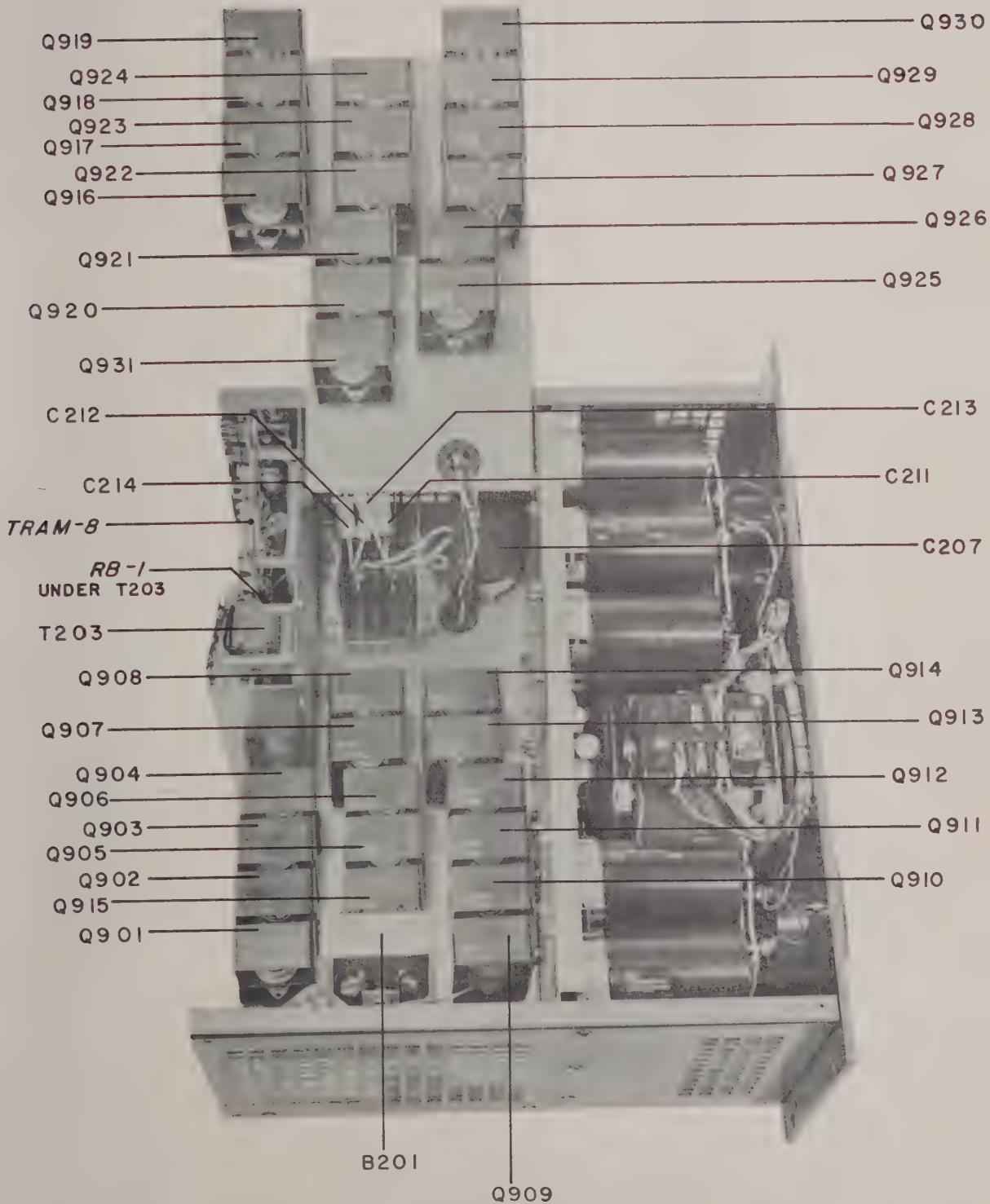
R205	- 10	Ohm	20 watt WW
R206	- 500	Ohm	20 watt WW
R301	- 30	Ohm	3 watt WW
R302	- 470	Ohm	1/2 watt
R303	- 2	K	2 watt
R304	- 3.3	K	1/2 watt
R305	- 47	Ohm	1/2 watt
R306	- 430	Ohm	1/2 watt
R401	- 82	K	1/2 watt
R901 thru R930	- 1.5	Ohm	3 watt WW
RL201	- 4PDT Relay		
RL202	- SPDT Relay		
S101	- SPST Switch		
S901	- Thermoswitch N. C.		
T101	- Powerstat Type Q116U		
T201	- Kepco #100-1143		
T202	- Kepco #100-1142		
T203	- Kepco #100-1039		
TB201	- Jones #8-142-Y		

PARTS LIST

DRAWING S-TRAM-8-01

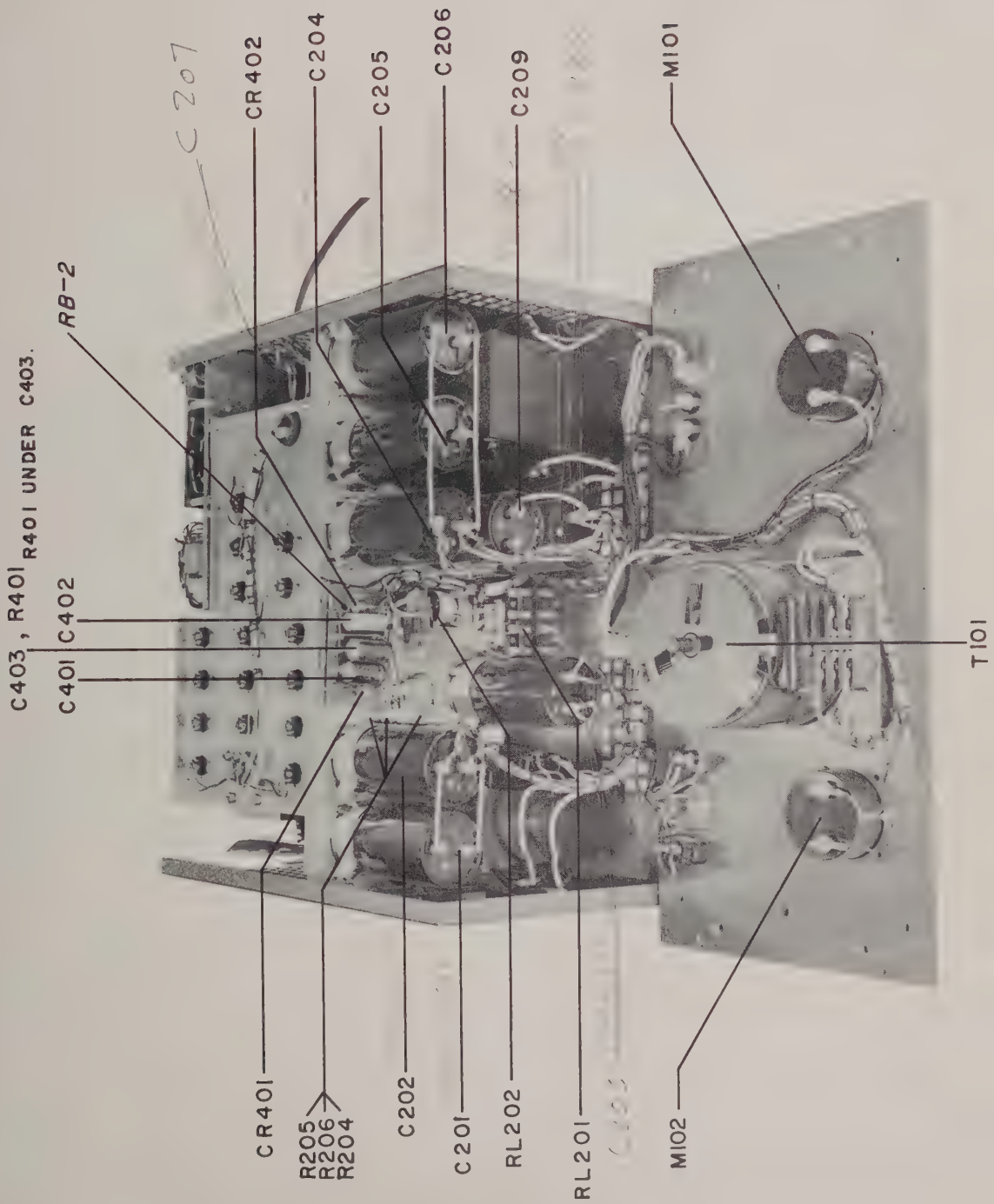
C1	- 25	MF	25 WV
C2	- 2	MF	200 WV
C3	- 0.4	MF	50 WV
C4	- 0.1	MF	500 WV
Q1	-	Transistor 2N441	
Q2 thru Q6	-	Transistor 2N382 (Alternate 2N383)	
Q7	-	Transistor 2N35 (Alternate GT-1092)	
Q8	-	Transistor 2N382 (Alternate 2N383)	
Q9	-	Transistor GT-1092	
Q10	-	Transistor GT-1092	
Q11	-	Transistor 2N382 (Alternate 2N383)	
Q12	-	Transistor 2N382 (Alternate 2N383)	
R1	- 3.3	K	1/2 watt
R2	- 2.2	K	1/2 watt
R3	- 500	Ohm	3 watt WW
R4	- 500	Ohm	3 watt WW
R5	- 4.7	K	1/2 watt
R6	- 2.5	K	3 watt WW
R7	- 2.5	K	3 watt WW
R8	- 10	K	3 watt WW
R9	- 1.8	K	1/2 watt
R10	- 2.5	K	3 watt WW
R11	- 500	Ohm	3 watt WW
R12	- 1.8	K	1/2 watt WW
R13	- 100	Ohm	3 watt WW
R14	- 100	Ohm	3 watt WW
R15	- 4.7	K	1/2 watt
R16	- 220	Ohm	1/2 watt
R17	- 10	Ohm	1/2 watt
R18	- 1	K	1/2 watt
R19	- 1.6	K	1/2 watt
R20	- 2.7	K	1/2 watt
R21	- 300	Ohm	1/2 watt
R22	- 4.7	K	1/2 watt
R23	- 47	Ohm	1/2 watt
R24	- 4.7	Ohm	1/2 watt WW
R25	- 300	Ohm	2 watt Pot.
R26	- 200	Ohm	3 watt WW
RD1	-	Diode 1N429	

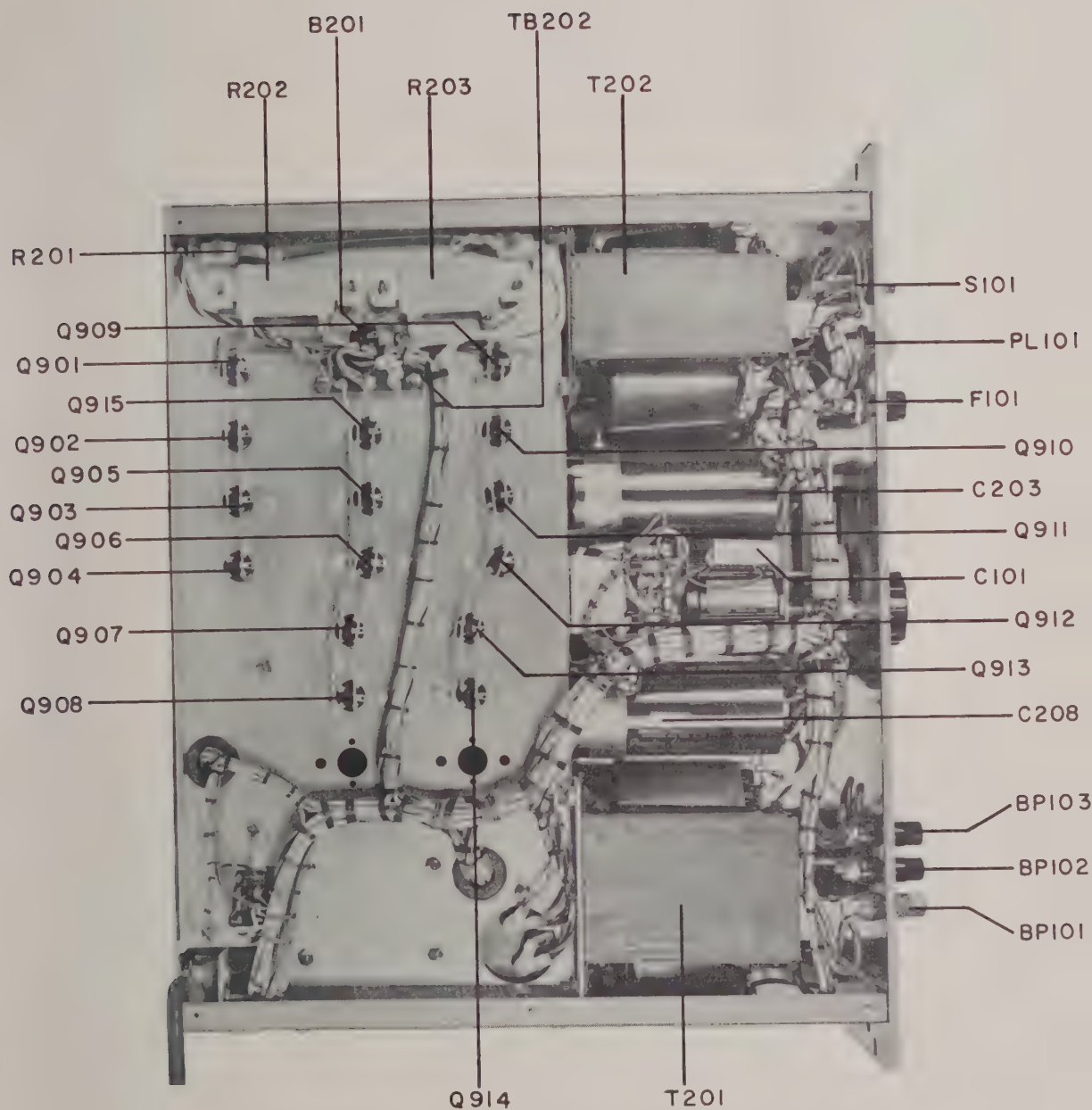
SC-32-15A



TOP

SC-32-15A INTERIOR

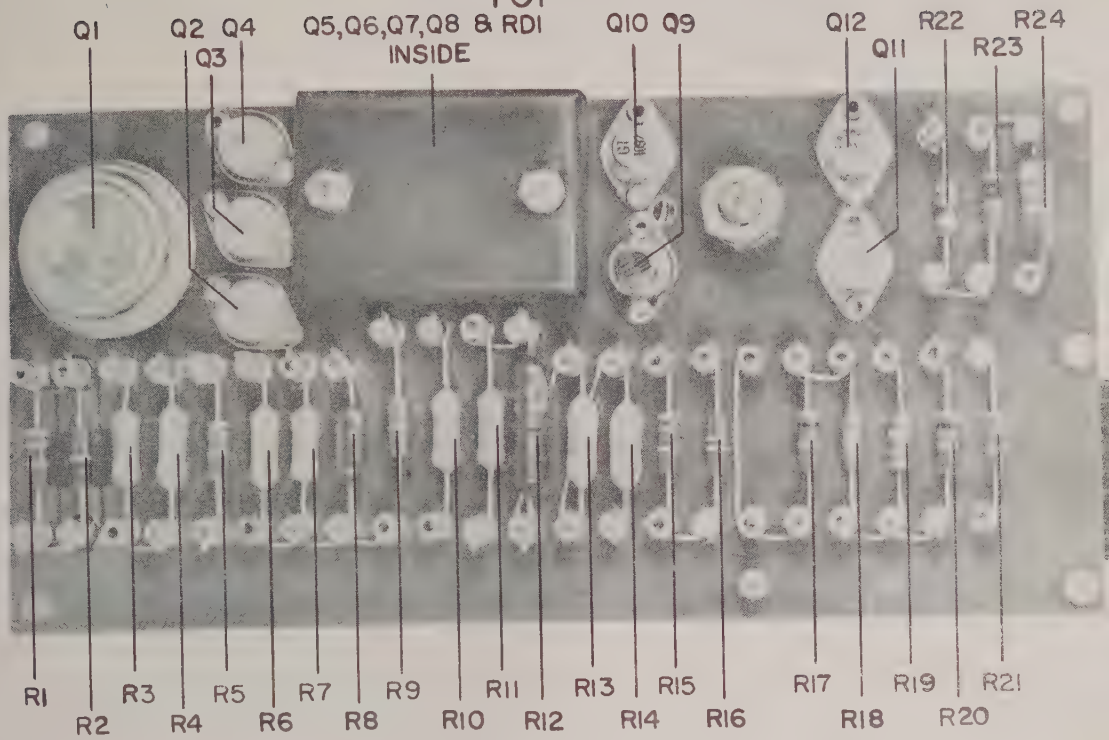




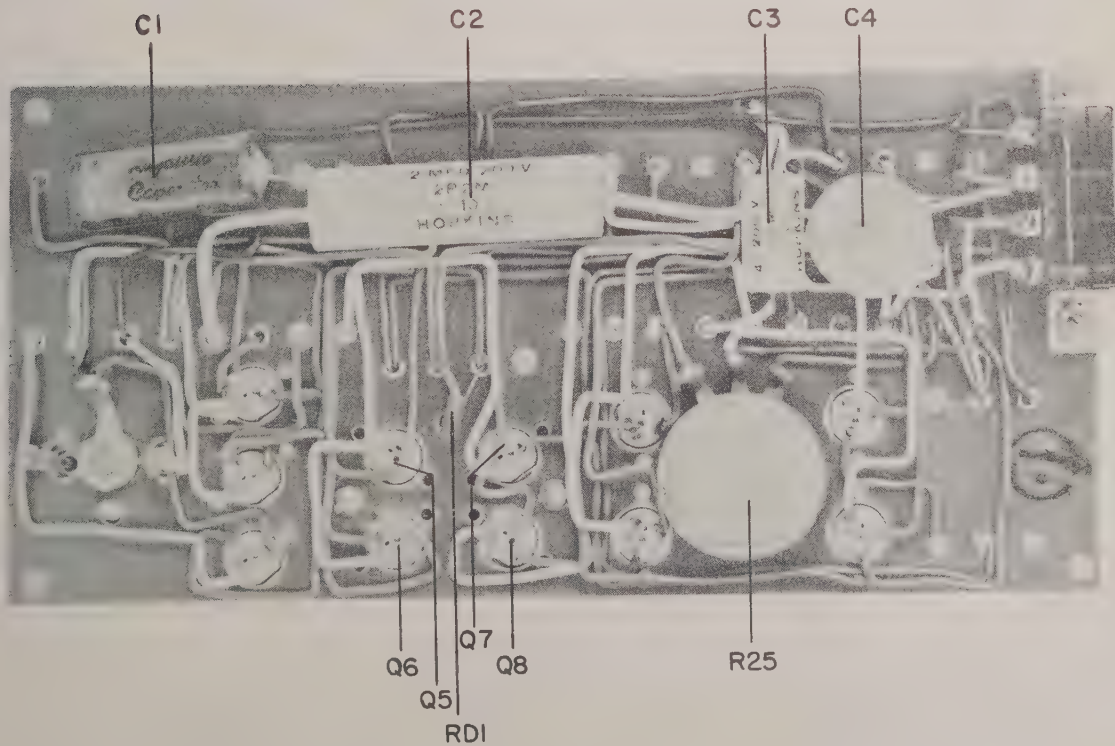
SC-32-15A

BOTTOM

TRAM 8 TOP

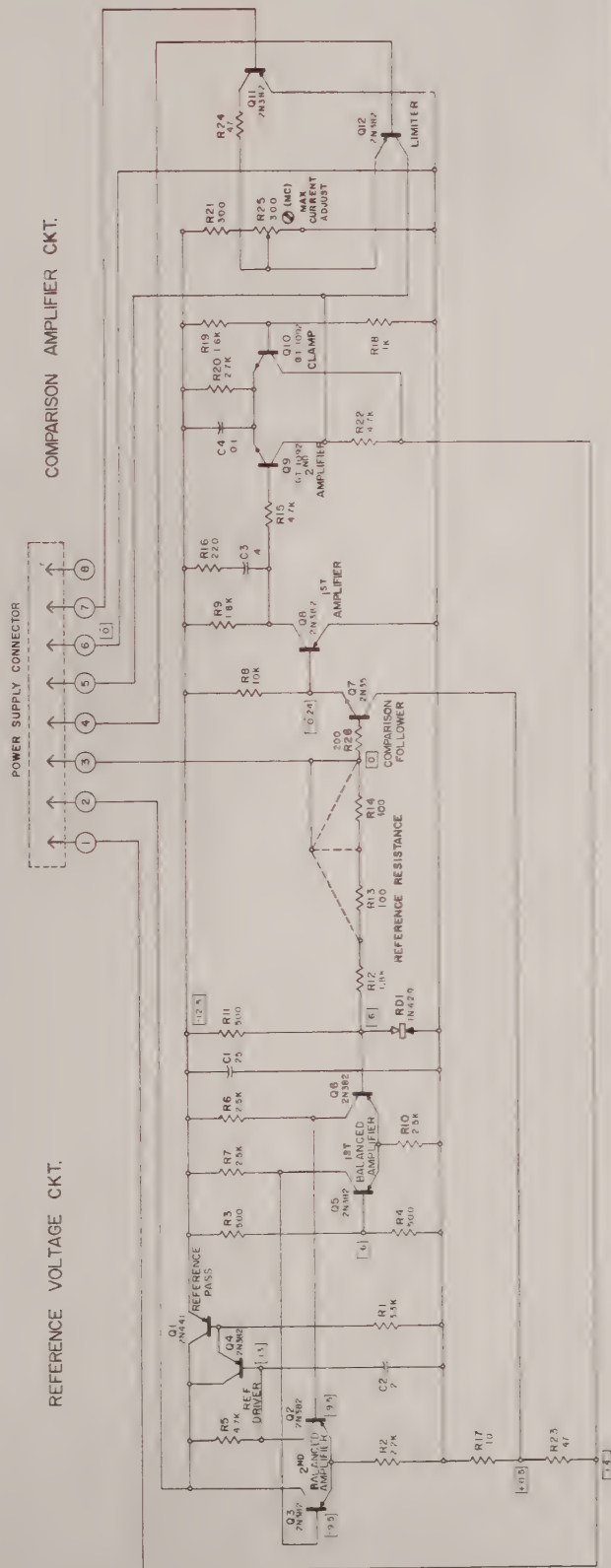


BOTTOM



COMPARISON AMPLIFIER CKT.

REFERENCE VOLTAGE CKT.



NOTE
1. ALL VOLTAGES TAKEN UNDER CONDITIONS SPECIFIED ON MAIN SHEET.

